



Intel® Xeon™ Processor System Bus Over/Undershoot Verification

Application Note

May, 2001



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Revision History

Revision	Date
2.0	May, 2001

1.0 Introduction

The Intel® Xeon™ processor has overshoot and undershoot specifications for all system bus signals. These specifications stipulate that a signal at the output of the driver buffer and at the input to the receiver buffer must not exceed a maximum absolute overshoot voltage limit (2.3V) and a minimum absolute undershoot voltage limit (-0.65V) assuming a V_{CCMAX} of 1.70V. Refer to the latest version of the *Intel® Xeon™ Processor Datasheet* for additional details regarding these specifications. Exceeding these limits will cause damage to the processor. There is also a time dependent, non-linear overshoot requirement above V_{CC} and undershoot requirement below GND that is dependent on the amplitude and duration of the overshoot or undershoot.

The overshoot and undershoot checker utility, *gowsim*, has been developed to check for all three of these requirements. This is a post-processing utility that evaluates an OEM generated ASCII data file, which contains time in the first column, followed by space(s), and node voltage in the second column. The data points are taken at the input, output, or I/O pads of the processor. The utility evaluates the data and informs the user pass or fail results. This utility should be run on the results of all simulations to verify there are no violations to these specifications. Measurement data taken with an oscilloscope may also be converted to voltage versus time format and fed into the utility. However, this data is referenced to the pins of the processor or the vias on the motherboard. The processor specifications for undershoot and overshoot are referenced at the die pads.

Figure 1 Example System Bus Signal Waveform

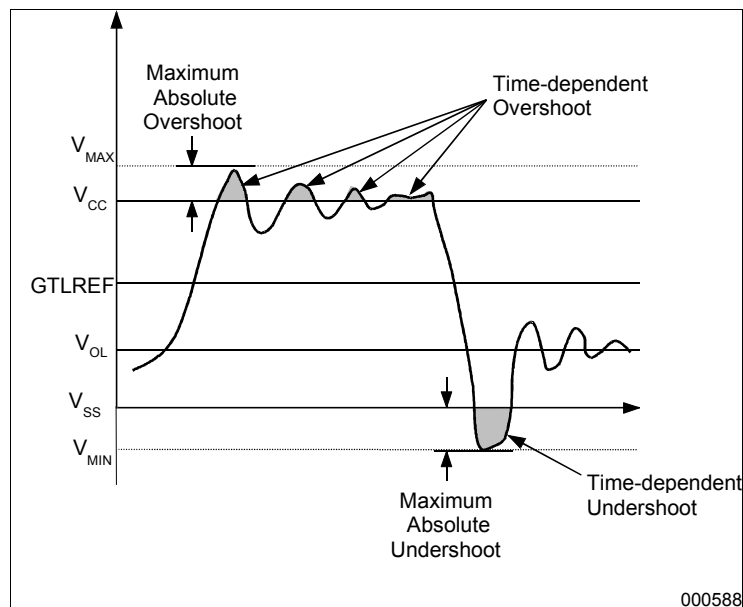


Table 1 Overshoot and Undershoot Parameters

Parameter	Description	Specification	Units	Notes
V _{CC} MAX	Maximum operating voltage for the processor, equivalent to V _{cc} VID (Voltage ID)	1.70	V	1
V _{MAX}	Maximum absolute voltage for system bus signals at the input of the receiver buffers	2.30	V	1
V _{MIN}	Minimum absolute voltage for system bus signals at the input of the receiver buffers	- 0.65	V	1
Overshoot	Time dependent overshoot amount above V _{cc}			2
Undershoot	Time dependent undershoot amount below GND			2

Notes:

1. Refer to the processor datasheet for actual specifications. In the event of a discrepancy between this document and the datasheet, the datasheet supersedes.
2. These parameters cannot be specified in absolute terms. They can only be verified through the use of the *gowsim* utility.



2.0 Tool Operation

The program used in the verification process solely relies on the Time-Voltage data file that is extracted from the simulation results. **The tool expects at least three (3) clock cycles of data transition simulation to evaluate the integrity of the layout.**

The ASCII data file format requirements are:

The two columns should be time, followed by “space(s)”, then followed by voltage.

No column headers or empty rows.

Voltage should be in Volts; time units are not important so long as they are consistent (this may sound surprising, but think of it as the time units canceling out).

The format of the numbers is not important (0.0001 versus 1.000E-4).

The overshoot checker processes the Time-Volt files and returns whether or not the waveforms meet the overshoot/undershoot requirements (see Table 2 for pass/fail messages). It is possible that a waveform can report all three failure signatures. The verification process typically takes under a minute for all the files extracted from the simulations. *Gowsim* is available in separate executables for three UNIX* operating systems as well as an executable for Windows* based workstations:

- IBM* AIX* (compiled under version 4.1)
- Hewlett-Packard* HP-UX* (compiled under version V.10.20)
- Sun* Microsystems Solaris* (compiled under version System 5, Release 4.0)

To execute *gowsim* in a UNIX environment, simply type “./gowsim_*platform*” (where *platform* is either hp, ibm, or sun) and the input file name, as shown below. For the Windows environment, open a command prompt window and type “gowsim_nt” and the input file name. The program takes as an argument the name(s) of the .wvs file(s):

- Example: /gowsim_ibm filename.wvs
- Example: gowsim_nt filename.wvs

The program will output one of the five messages listed in below.

Table 2 Gowsim Output Examples

Message	Description
PASSED	Signal waveform meets overshoot/undershoot requirements
FAILED: Exceeded maximum voltage of 2.30 V	Signal waveform exceeds the absolute maximum voltage requirement
FAILED: (Exceeded minimum voltage of -0.65V)	Signal waveform exceeds the absolute minimum voltage requirement
FAILED: Overshoot/ undershoot exceeded	Signal waveform exceeds the time dependent overshoot above V_{CTERM} /undershoot below GND
UNKNOWN: (Did not have three complete cycles)	Waveform did not have at least three complete cycles of data transition

2.1. Example

Copy the “Time-Volt” data file(s), for all the nodes, into one directory and run the *gowsim* utility at once:

- Example input file: Input_sim_data.wvs:

```
0.000 0.446
0.010 0.460
0.020 0.479
0.030 0.500
0.040 0.522
0.050 0.546
---
0.660 2.005
0.670 2.010
0.680 2.013
0.690 2.012
0.700 2.009
0.710 2.003
0.720 1.994
...
```

- Example command line: `./gowsim_ibm input_sim_data.wvs`

The tool prints the evaluation result for each file name to the screen.



3.0 Known Issues

The tool has a maximum input of 50,000 lines.

The tool will not accept redundant values in the time column. Take care in using tools that may truncate significant digits such as spreadsheet programs.

4.0 Failure Analysis

In the case of a waveform failure, examine the waveform to make sure there is no obvious flaw in the simulation resulting in an excessively high-voltage pulse. If there is no flaw in the data, then the only recourse to meet the processor specifications is to attempt to design the system bus with less overshoot above Vcc and/or less undershoot below GND. Excessive overshoot or undershoot failures can be rectified by decreasing the amplitude of the overshoot/undershoot and reducing the duration of the overshoot/undershoot. Since there is an exponential relation between the signal voltage and the overshoot/undershoot requirement, it is normally far more effective to attempt to reduce the overshoot/undershoot voltage rather than the overshoot/undershoot duration.

Also note that the *gowsim* utility applies pass/fail criteria to the worse case waveform contained in the Time-Volt input file and, by default, assumes that the magnitude and duration of the worse case waveform occurs on every clock cycle (activity factor = 1). Activity factor can be adjusted by adding “-act <num>” in the command line for *gowsim*. Activity factor of 0.1 indicates that the overshoot or undershoot condition occurs every 10 system bus clock cycles, 0.01 every 100 clock cycles, etc.

- Example: `gowsim_nt -act 0.01 filename.wvs`